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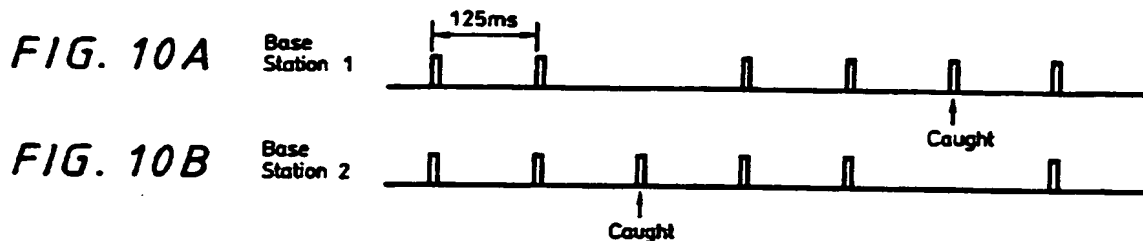
UK CL (Edition N) H4L LDLX LDSX

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(54) Avoiding Signal Collision in a Cordless Telephone System

(57) A digital cordless telephone system is controlled by a control channel carrying control data in a slot intermittently transmitted at a constant interval. These data transmissions are (pseudo-) randomly suppressed so that control signals arriving at a base stations from mobiles in two non-synchronized systems at the same times do not collide at every occurrence, and are caught by the base station.



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FIG. 1

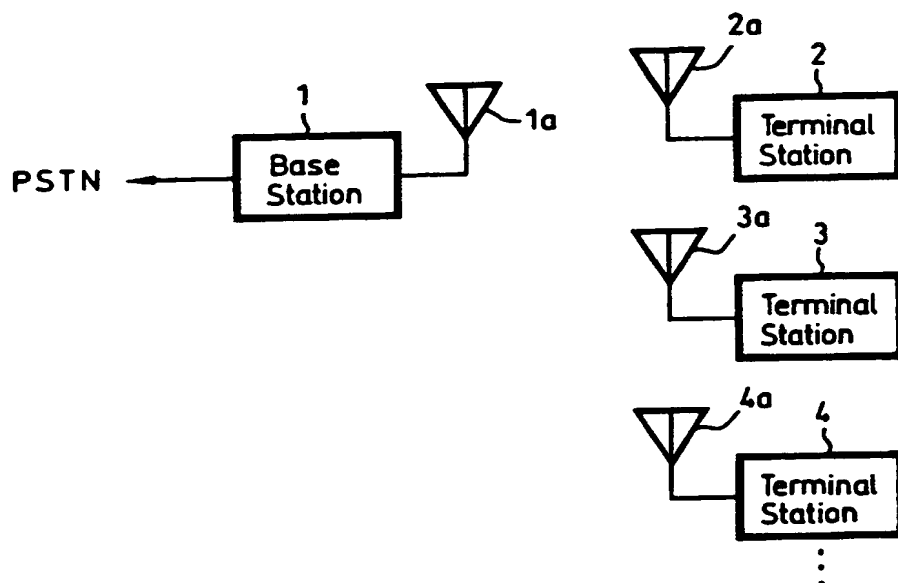


FIG. 2A TDD System

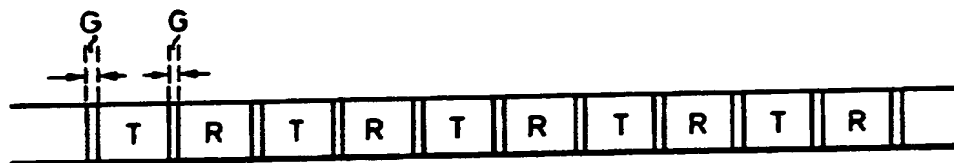
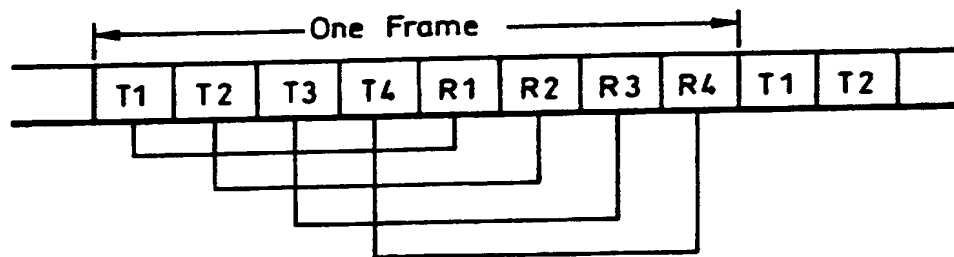


FIG. 2B TDMA System



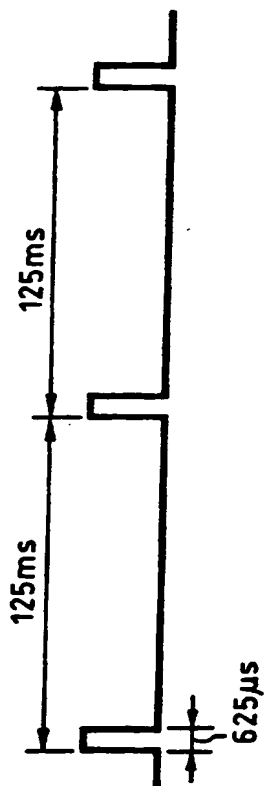


FIG. 3A Base Station 1

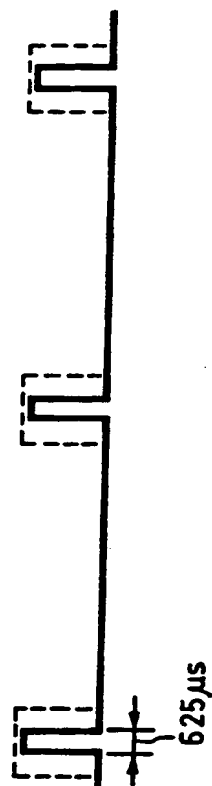


FIG. 3B Base Station 2

FIG. 4

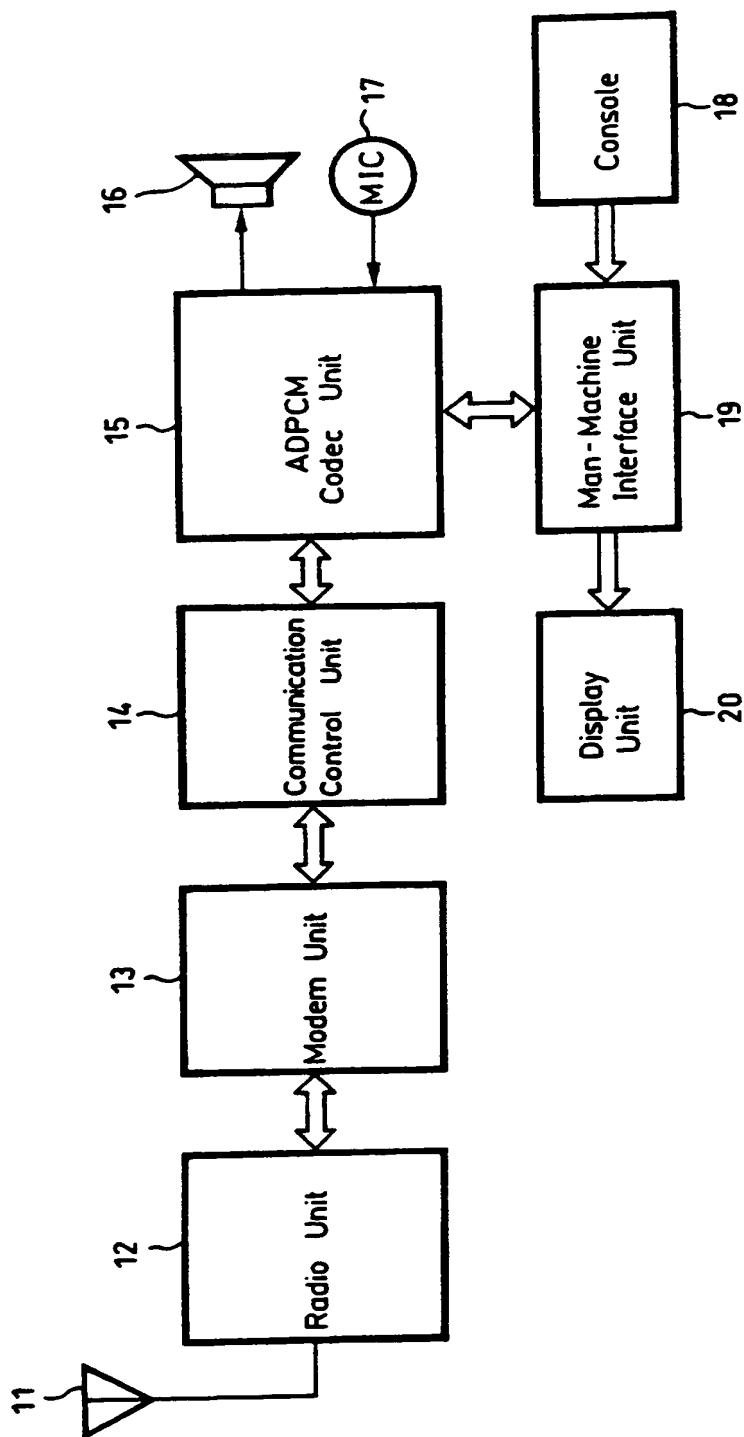


FIG. 5

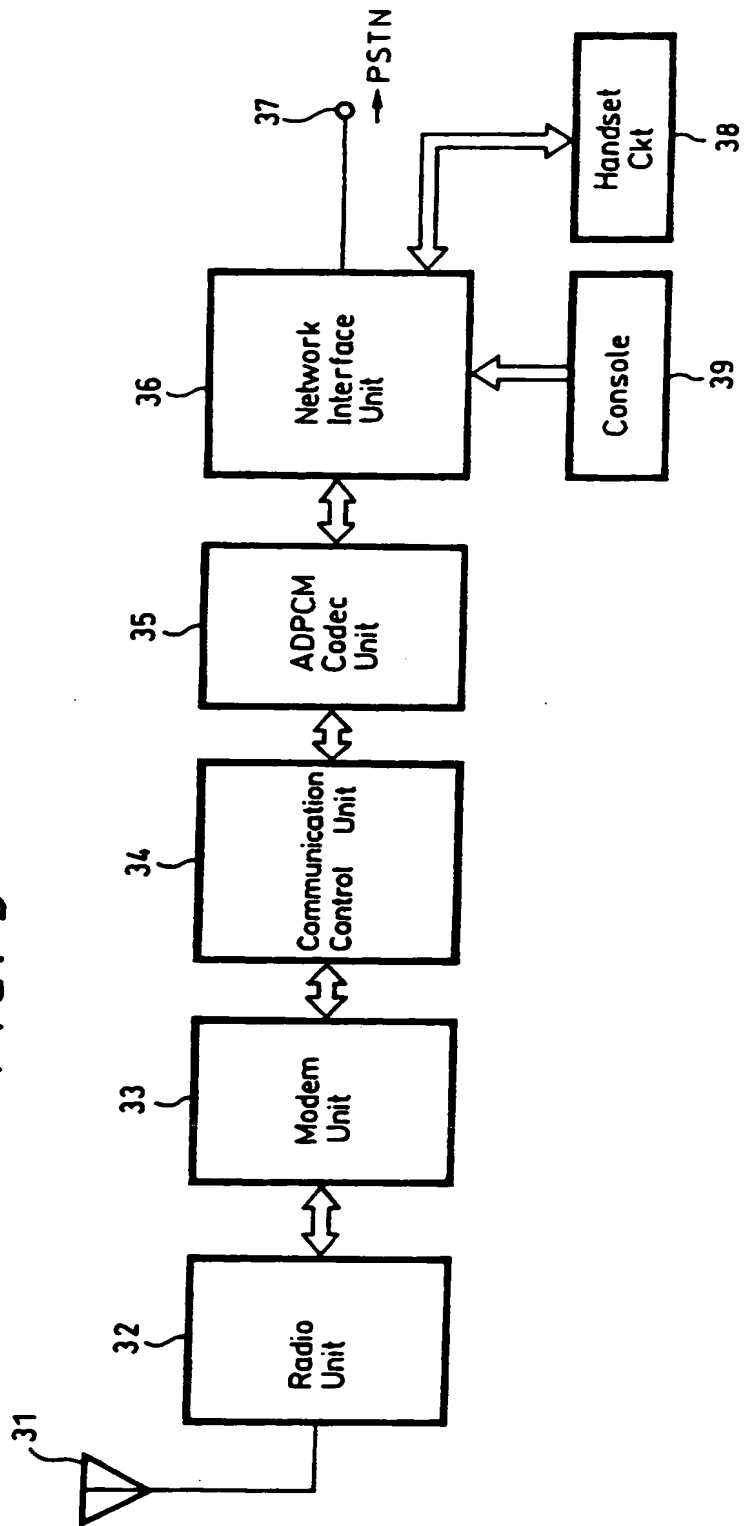


FIG. 6

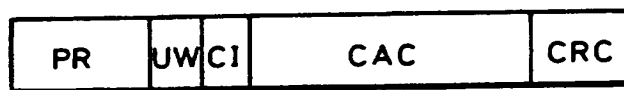


FIG. 7

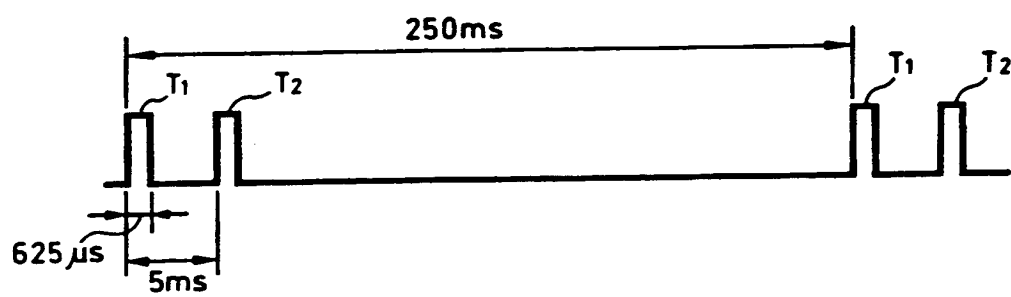
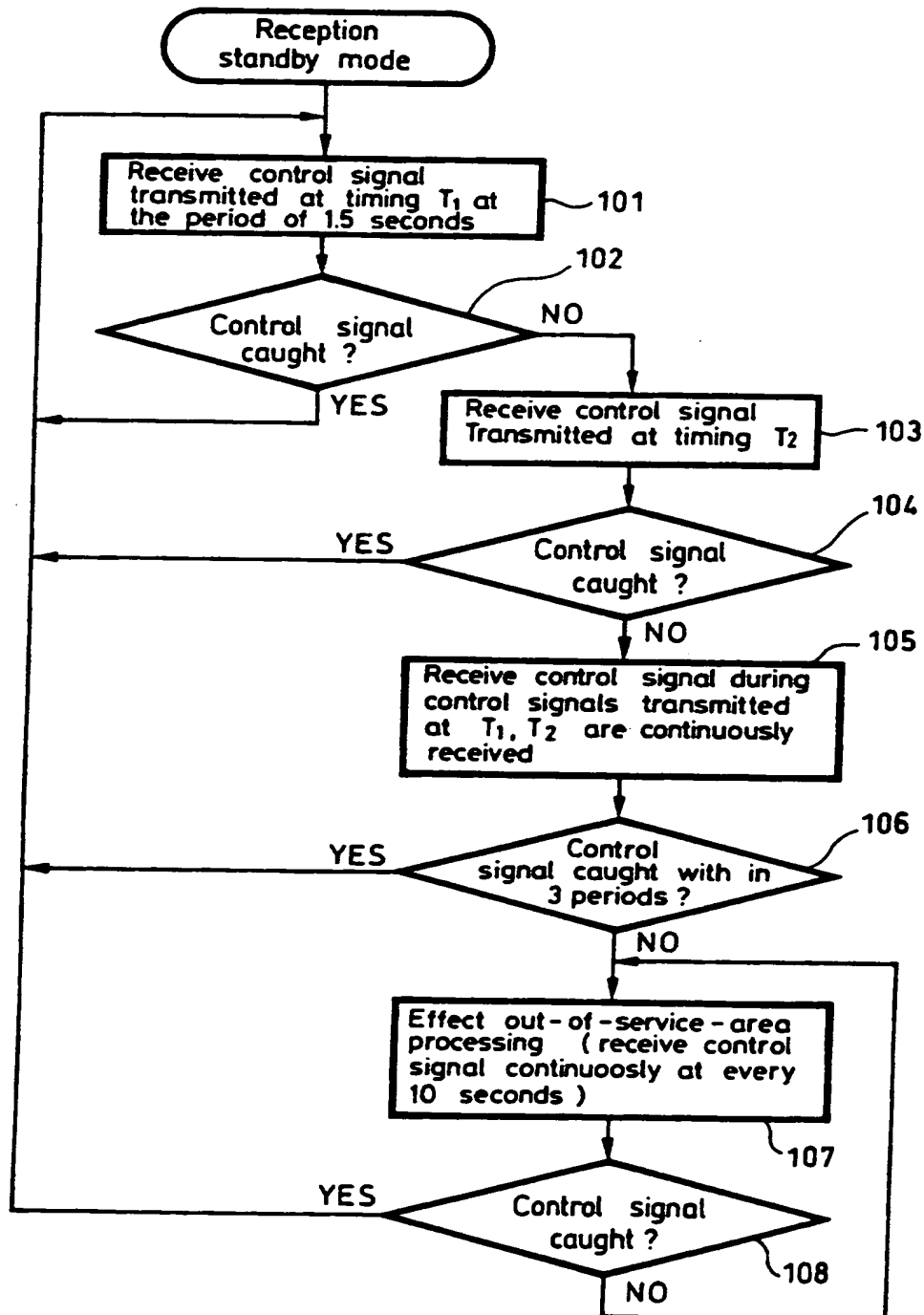


FIG. 8



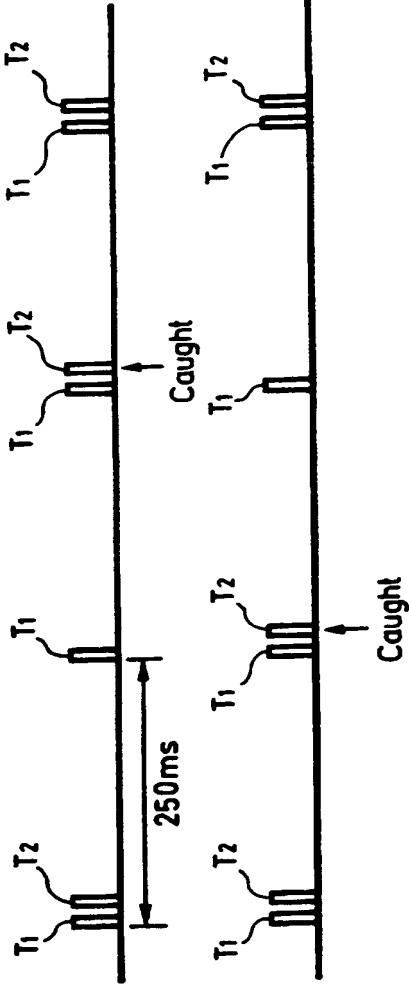
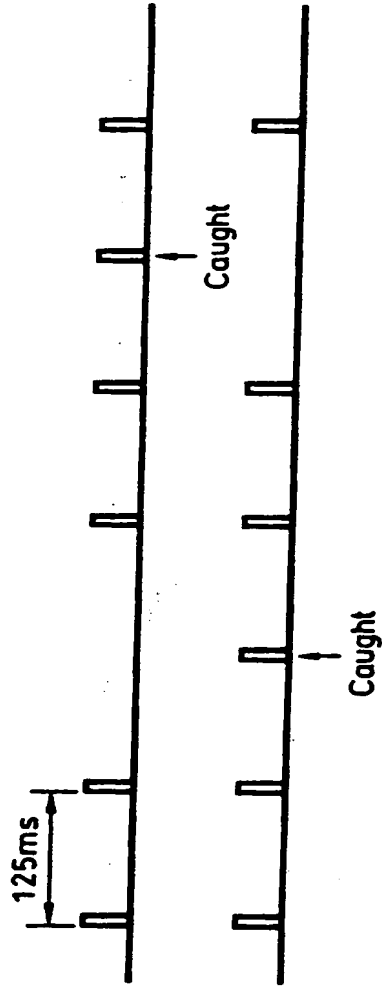


FIG. 9A Base Station 1

FIG. 9B Base Station 2



Base Station 1

Base Station 2

FIG. 10A

FIG. 10B

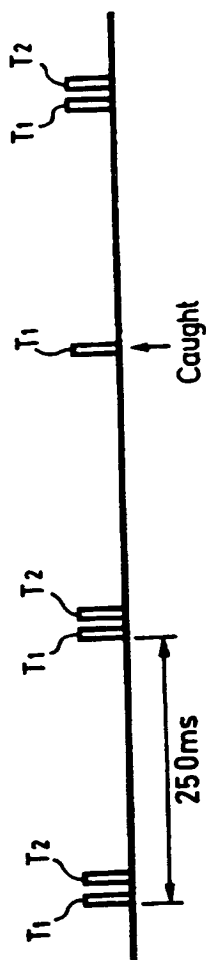


FIG. 11A Base Station 1

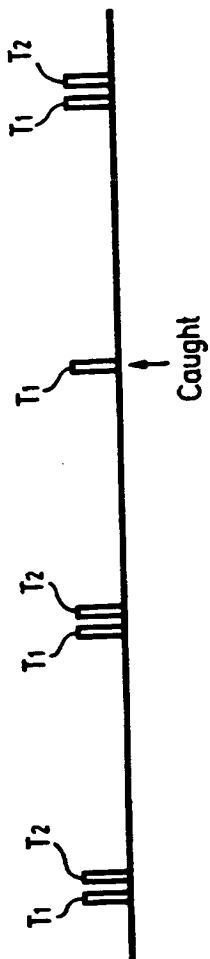


FIG. 11B Base Station 2

CORDLESS TELEPHONE SYSTEM

The present invention relates to a digital cordless telephone system, such as a PHS (personal handy phone system) in Japan and a DECT (digital European cordless telecommunications), for communicating a base station and a terminal station by transmitting and receiving digital data and, more particularly to a base station of a digital cordless telephone system.

FIG. 1 of the accompanying drawings shows a digital cordless telephone system in block form. As shown in FIG. 1, a base station 1 is connected to a PSTN (public switched telephone network) and includes an antenna 1a for making a communication between it and a terminal station. There are prepared a plurality of, e.g., three terminal stations, i.e., terminal stations 2, 3, 4 which are capable of communicating with the base station 1. Antennas 2a, 3a, 4a are attached to the terminal stations 2, 3, 4 and digital data is transmitted and received among the antenna 1a of the base station 1 and the antennas 2a, 3a, 4a of the terminal stations 2, 3, 4 via radio waves.

When each of the terminal stations 2, 3, 4 communicates with the base station 1 (or the called party connected to the base station 1 via the PSTN), the terminal station transmits a connection control signal of a predetermined format to the base station 1 and communicates with the base station 1 by transmitting audio data converted in the form of time-division digital data.

The digital cordless telephone system uses a TDD (time division duplex) system in which a transmission frequency and a reception frequency are the same. Also, the digital cordless telephone system uses a TDMA (time division multiple access) system for transmitting a plurality of communication signals at the same frequency during different periods.

Specifically, in the case of the TDD system, as shown in FIG. 2A, one channel (frequency) is divided into a

transmission slot T and a reception slot R from a time standpoint and these transmission and reception slots T, R are repeated alternately. Moreover, a guard time G is provided between these slots T and R. A duration of each of the slots T and R is selected to be 1 millisecond and a duration of the guard time G is selected to be several 10s of microseconds. In the portable telephone (terminal station), the transmission slot T communicates with the base station (master station) and the reception slot R receives audio data from the base station.

In the case of the TDMA system, as shown in FIG. 2B, the transmission slot T and the reception slot R disposed within one channel are used only one time during several periods in order to communicate the single terminal station and the base station. Other transmission slot T and reception slot R disposed within the same channel are used in order to communicate other terminal station and the base station. Thus, digital data is multiplexed in order to make a communication among a plurality of communication apparatus by one channel.

Since audio data is multiplexed as described above, the frequency band prepared for the cordless telephone can be used efficiently. When such communication is carried out, the control signal is transmitted from the base station to each terminal station by transmitting the control signal of slot arrangement at every predetermined period by use of different channel (control channel) from the transmission and reception channels of the communication signal of the slot arrangement. Specifically, as shown in FIG. 3A, the base station repeatedly transmits a control signal with slot of 625 microseconds at the period of 125 milliseconds. The reason that the control signal is transmitted at the period of 125 milliseconds is that the control signal is transmitted less than 8 times per second according to the standards of this kind of digital cordless telephone. When the control signal is transmitted 8 times per second at the equal interval, the period becomes 125 milliseconds.

Each terminal station can discriminate control information indicative of assignment of slots used in transmission and reception by receiving the transmitted control signal. A communication between the base station and the terminal station becomes possible by use of the slots designated by the control information. When each terminal station is called by an incoming call or incoming call of the extension, the base station transmits control information indicative of the terminal station called by the incoming call or incoming extension by the control signal. Accordingly, each terminal station has to receive the control signal constantly even under being placed in the reception standby mode. In this case, however, from a standpoint of power consumption in the reception standby mode, it is very useless for the terminal station to receive all control signals transmitted from the base station at the interval of 125 milliseconds under being placed in the reception standby mode. Accordingly, in actual practice, each terminal station intermittently receives the control signal once per several seconds.

If a plurality of systems are located in the areas close to each other, there is then the possibility that control signals transmitted from the respective base stations will interfere with each other, thereby making it impossible for the terminal stations of the respective system to receive the control signals.

Specifically, let it be assumed that two base stations of the cordless telephone systems where the transmitted states of the control signals are the same are located at the places comparatively close to each other (e.g., within a range of 100m). Also let it be assumed that the transmission timings of the control signals from the two base stations are almost agreed with each other as shown in FIGS. 3A and 3B. At that time, a terminal station located in the area being capable of receiving the control signals transmitted from the two base stations are urged to receive the control signals from the two base stations at the same

time. As a result, this terminal station cannot accurately discriminate data contained in the control signal of each slot. If the terminal station becomes unable to discriminate the control signal, then such terminal station becomes unable to set a communication between it and the base station. Thus, the digital cordless telephone system cannot be used as the cordless telephone.

In actual practice, even though the transmission timings of the control signals of one slot of 625 microseconds are not completely agreed with each other, if the control signal is transmitted from the base station at a timing overlapping a little a leading or trailing edge of other control signal (control signal shown in FIG. 3A) as shown by phantoms in FIG. 3B, there is then the large possibility that the control signal will not be received by the terminal station.

Assuming now that an oscillation accuracy difference of clocks for determining timings at which the two base stations transmit control signals is 5 ppm, then the transmission timing of the control signal is shifted by 5 microseconds per second. If the transmission timings of the two control signals start overlapping at a certain time, then the control signals interfere with each other over 375 seconds because $625 \times 3/5 = 375$. As a consequence, the terminal station cannot receive an incoming call and cannot make an outgoing call during a time period of 375 seconds.

In view of the aforesaid aspect, it is an object of the present invention to provide a cordless telephone system in which control signals transmitted from a plurality of base stations can be prevented from interfering with each other.

According to a first aspect of the present invention, there is provided a base station of a digital communication system comprising:

radio frequency processing means for processing an RF signal for transmitting and/or receiving digital data; and communication control means for controlling a communication to one or more terminal stations using a

control channel, wherein said communication control means makes a control signal which has periodic pulses and some of said periodic pulses are randomly or pseudo-randomly extinguished.

5 According to a second aspect of the present invention, there is provided a terminal station of a digital communication system comprising:

 radio frequency means for receiving an RF signal;
and

10 synchronizing means for synchronizing a signal in a received RF signal from a base station, wherein said synchronizing means synchronizes a signal supplied thereto from said base station if said synchronizing means catches a synchronizing signal from said base station and executes
15 another process if said synchronizing means does not catch said synchronizing signal from said base station.

 According to a third aspect of the present invention, there is provided a communication system comprising:

20 a base station; and

 one or more terminal stations of a digital signal, wherein said communication system uses a control signal which has periodic pulses and some of said pulses are randomly or pseudo-randomly extinguished.

25 In accordance with a fourth aspect of the present invention, there is provided a method of receiving a control signal comprising the steps of:

 receiving a first control signal in a first manner;
 receiving a second control signal if said first
30 control signal has not yet been received; and

 receiving said first or second control signal in a second manner if said second control signal has not yet been received.

 In accordance with a fifth aspect of the present
35 invention, there is provided a method of sending a control signal in a base station of a digital communication system comprising the steps of:

making a control signal having periodic pulses,
some of which are randomly or pseudo-randomly extinguished;
and

transmitting an RF signal modulated by at least
5 said control signal made from said control signal making
step.

The invention will be further described by way of
non-limitative example with reference to the accompanying
drawings, in which:-

10 FIG. 1 is a schematic block diagram showing a
cordless telephone system;

FIGS. 2A and 2B are schematic diagrams showing
communication systems of a cordless telephone system;

FIGS. 3A and 3B are timing charts showing a manner
15 in which control signals are transmitted;

FIG. 4 is a schematic block diagram showing a
terminal station according to an embodiment of the present
invention;

FIG. 5 is a schematic block diagram showing a base
20 station according to the embodiment of the present invention;

FIG. 6 is a schematic diagram showing a slot of a
control signal according to the present invention;

FIG. 7 is a timing chart showing a manner in which
a control signal is transmitted;

25 FIG. 8 is a flowchart showing a processing executed
under the condition that the terminal station is placed in
the standby state;

FIGS. 9A and 9B are timing charts showing a manner
in which control signals are transmitted from a plurality of
30 base stations according to the embodiment of the present
invention;

FIGS. 10A and 10B are timing charts showing a
manner in which control signals are transmitted from a
plurality of base stations according to another embodiment of
35 the present invention; and

FIGS. 11A and 11B are timing charts showing a
manner in which control signals are transmitted from a

plurality of base stations according to a further embodiment of the present invention.

A digital cordless telephone system according to a first embodiment of the present invention will hereinafter be described with reference to FIGS. 4 to 9.

FIG. 4 shows a terminal station of a TDMA type cordless telephone system. As shown in FIG. 4, data received at an antenna 11 from a base station or other terminal station is received by a radio unit 12 and supplied to a modem (modulator/demodulator) unit 13 which demodulates received data. The received data thus demodulated by the modem unit 13 is supplied through a communication control unit 14 to an ADPCM (adaptive differential pulse code modulation) codec unit 15, in which received ADPCM digital data is converted to an analog audio signal. This analog audio signal is output from a speaker 16.

An audio signal picked up by a microphone (MIC) 17 is supplied to the ADPCM codec unit 15, in which it is converted to ADPCM digital data. This ADPCM digital data is supplied through the communication control unit 14 to the modem unit 13, in which it is modulated into transmission data. The modulated transmission data is transmitted from the antenna 11 connected to the radio unit 12.

A console 18 is connected through a man-machine interface unit 19 to the ADPCM codec unit 15, whereby operation information from the console 18 is supplied to the communication control unit 14 side. A display unit 20 is connected to the man-machine interface unit 19 in order to display various states of the terminal station, such as an operation state.

The communication control unit 14 controls a receiving operation in either manner for receiving only a control signal transmitted through a predetermined control channel from the base station at a predetermined interval or manner for receiving both the control signal from the base station at the predetermined interval and a direct connection request signal directly transmitted from other terminal

station at a predetermined interval when the terminal station is placed in the reception standby mode. A manner in which the reception operation is switched when the terminal station is placed in the reception standby mode will be described
5 later on.

Then, the communication control unit 14 discriminates the content of the received control signal. If it is determined by the communication control unit 14 that the terminal station is called by the connection request
10 signal contained in the control signal, then the communication control unit 14 places this terminal station in the corresponding operation mode. Respective terminals stations are called by the connection request signal transmitted from the base station in order to make a
15 communication between it and the base station for extension call or making an outgoing call or answering an incoming call or in order to make a communication between it and other terminal station for extension call.

When each terminal station transmits an audio
20 signal in order to answer an incoming call or make an outgoing call or to make an extension call, the terminal station transmits the connection request signal to the base station by use of a control channel under control of the communication control unit 14. A timing at which the
25 connection request signal is transmitted is set so as not to overlap a timing at which the control signal is transmitted from the base station.

FIG. 5 shows a base station. Similarly to the terminal station, data received at an antenna 31 from the
30 terminal station is received by a radio unit 32 and supplied to a MODEM unit 33 which demodulates received data. The received data thus demodulated is supplied through a communication control unit 34 to an ADPCM codec unit 35, in which received ADPCM digital data is converted into an analog
35 audio signal. This analog audio signal is supplied to a network interface unit 36, from which it is transmitted to a connection terminal 37 connected to the PSTN.

An analog audio signal from the analog telephone network connection terminal 37 is supplied through the network interface unit 36 to the ADPCM codec unit 15, in which it is converted into ADPCM digital data. This digital data is supplied through the communication control unit 34 to the modem unit 33, in which it is modulated into transmission data. The modulated transmission data is transmitted from the antenna 31 connected to the radio unit 32 via radio waves.

10 A handset circuit 38 is directly connected to the network interface unit 36 so as to enable the user to communicate with the called party through the analog telephone network connection terminal 37. Also, the handset circuit 38 is connected through the network interface unit 36
15 to the ADPCM codec unit 35 so as to enable the base station to communicate with the terminal station via extension. Further, a console 39 is connected to the network interface unit 36 to thereby perform a variety of control operations, such as making an outgoing call.

20 The communication control unit 34 of the base station can transmit a control signal periodically under a predetermined state by use of a channel (frequency band) exclusively-prepared for transmitting a control signal. Other terminal station is called by this control signal. The
25 communication control unit 34 detects whether or not other terminal station transmitted a connection request signal for making a communication between terminal stations. When the user wishes to make a call between the terminal station and the base station by this connection request signal, the base
30 station instructs a communication channel to the terminal station by the control signal to start a communication for making a call between it and the base station.

The control signal transmitted from the base station of this embodiment has a slot with a duration of 625
35 microseconds and has a format shown in FIG. 6. Specifically, as shown in FIG. 6, the control signal is composed of a preamble PR with a constant pattern of a predetermined

duration, a unique word UW with a specific pattern indicative of a control signal, a channel type CI for making a communication, control data CAC indicative of control content and an error-detection parity CRC, in that order.

5 According to this embodiment, the control signal of which slot is arranged as described above is transmitted in the state shown in FIG. 7. Specifically, after the control signal whose one slot has a duration of 625 microseconds has been transmitted at a predetermined timing T_1 , a control
10 signal of the next slot is transmitted at a timing T_2 delayed from the above transmission start timing by 5 milliseconds. A transmission at the timing T_1 and a transmission at the timing T_2 are repeated at the period of 250 milliseconds. Further, according to this embodiment, a transmission of the
15 control signal at the timing T_2 is randomly stopped and extinguished. A timing at which the transmission at the timing T_2 is extinguished is determined based on a random number generated from a microcomputer (not shown) disposed within the communication control unit 34 of the base station,
20 for example. A transmission of the control signal at the timing T_1 is carried out at the period of 250 milliseconds without fail.

A manner in which the control signal is received under the condition that each terminal station is placed in
25 the reception standby mode for being called by the base station or other terminal station will be described with reference to a flowchart of FIG. 8. The terminal station is placed in the reception standby mode when the power switch of the corresponding terminal station is turned on or when a
30 telephone call (extension call or incoming call) at this terminal station is ended.

As shown in FIG. 8, when the terminal station is placed in the reception standby mode, the processing proceeds to the next step 101, whereat a control signal intermittently
35 transmitted from the base station is intermittently received and caught at the period of 1.5 seconds under control of the communication control unit 14 of the terminal station. In

this case, initially, the control channel is continuously received during a predetermined period to thereby catch the control signal transmitted at the timing T_1 of the period of 250 milliseconds. Then, the terminal station receives the control signal intermittently at the period of 1.5 seconds based on the timing at which the above control signal is caught.

It is determined at the next decision step 102 whether or not the control signal is caught during the control signal is intermittently received at the period of 1.5 seconds. If the control signal is caught as represented by a YES at decision step 102, then the processing returns to step 101, whereat the control signal is intermittently received at the period of 1.5 seconds. If the control signal is not received as represented by a NO at decision step 102, then the processing proceeds to step 103, whereat the control signal at the timing T_2 transmitted after 5 milliseconds of the timing T_1 is received. It is determined in the next decision step 104 whether or not the control signal at the timing T_2 is caught. If this control signal at the timing T_2 is caught as represented by a YES at decision step 104, then the processing returns to step 101, whereat the control signal is intermittently received at the period of 1.5 seconds on the basis of the timing at which the control signal transmitted at the timing T_1 is caught.

If on the other hand the control signal is not caught as represented by a NO at decision step 104, then the processing proceeds to step 105, whereat the control channel is received continuously. Then, it is determined in the next decision step 106 whether or not the control signal is caught during a time period (i.e., about 750 milliseconds) corresponding to three periods of the transmission period of the control signal when the control channel is received continuously. If the control signal is caught as represented by a YES at decision step 106, then the processing returns to step 101, whereat the control signal is intermittently received at the period of 1.5 seconds on the basis of the

timing at which the control signal transmitted at the timing T_1 is caught.

If on the other hand the control signal is not caught even when the control channel is continuously received
5 during the time period of three periods, then it is determined that the terminal station is located at the position which the terminal station cannot receive the control signal from the base station. Then, the processing proceeds to step 107, whereat a processing provided when the
10 terminal station is placed out of the service area is executed (hereinafter this processing will be referred to as "out-of-service-area processing" for simplicity). In this out-of-service-area processing, the control channel is intermittently received at every 10 seconds during a time
15 period of 510 milliseconds. It is determined at the next decision step 108 whether or not the control signal is caught while the control channel is intermittently received at every 10 seconds during a time period of 510 milliseconds. If the control signal is caught as represented by a YES at decision
20 step 108, then the processing returns to step 101, whereat the control signal is intermittently received at the period of 1.5 seconds on the basis of the timing at which the control signal transmitted at the timing T_1 is caught. If on the other hand the control signal is not caught as
25 represented by a NO at decision step 108, then the processing returns to step 107, whereat the out-of-service-area processing is carried out, i.e., the intermittent reception of the control signal at every 10 seconds is repeated.

A processing at the standby mode is executed under
30 control of the communication control unit 14 of the terminal station as described above. When the corresponding terminal station is called by the control signal caught at any stage, such terminal station transmits and receives slot data between it and the base station by use of the slot indicated
35 by the control signal.

When the control signal is caught by the processing executed in accordance with the flowchart of FIG. 8, the

control signal transmitted from the base station of the same system with a system code common to that of the terminal station is caught. Therefore, a control signal transmitted from a base station with a different system code is neglected
5 even though received.

In this way, each terminal station receives the control signal transmitted from the base station as shown in FIG. 7 to thereby catch the control signal satisfactorily. If the control signal is not caught, then the reception
10 processing is automatically switched to the out-of-service-area processing. Therefore, the terminal station can be placed in the standby mode for satisfactorily receiving a control signal regardless of the state where the terminal station is placed. According to this embodiment, if the
15 control signal transmitted at the timing T_2 as shown in FIG. 7 is randomly extinguished, there is then the small possibility that the control signal from the base station will interfere with a control signal transmitted from other base station. There is the large possibility that each
20 terminal station can receive the control signal satisfactorily.

Specifically, as shown in FIGS. 9A and 9B, for example, let it be assumed that two base stations 1 and 2 whose control signal transmission timings T_1 and T_2 are
25 substantially the same are located comparatively close to each other. A transmission of a control signal transmitted from one base station 1 as shown in FIG. 9A is stopped at the transmission timing T_2 . At that time, a control signal transmitted from another base station 2 at the timing T_2 as
30 shown in FIG. 9B can be caught by a terminal station with the same system code as that of this base station 2 (at the timing shown by an arrow in FIG. 9A). Similarly, let it also be assumed that a transmission of a control signal transmitted from another base station 2 at the timing T_2 is
35 stopped at another timing. Then, at that time, the control signal transmitted from one base station 1 at the timing T_2 as shown in FIG. 9A can be caught by a terminal station with

the same system code as that of the base station 1 (timing shown by an arrow in FIG. 9A).

Therefore, according to this embodiment, even when the transmission periods of the control signals from a plurality of base stations are agreed with each other, there exist timings at which the control signal can be caught by the terminal station with the result that a period in which a communication control (control of an outgoing call from the terminal station or control of an incoming call to the terminal station) is disabled can be reduced. Therefore, a communication can be prevented from being disabled during a long period of time. To be concrete, if control signals interfere with each other under the condition that each terminal station is placed in the reception standby mode, then the control signal cannot be caught at the timing T_1 at step 101 shown in FIG. 8. In this case, however, there is the large possibility that the control signal will be caught at step 103 shown in FIG. 8 or that the control signal will be caught during the control channel is continuously received at step 105 shown in FIG. 8. In worst cases, there is the large possibility that, after the processing proceeds to the out-of-service-area processing, the processing will be returned to the ordinary processing at the relatively early stage.

According to the present invention, a time period in which the control signal cannot be caught can be reduced considerably as compared with the case that the control signal cannot be caught by each terminal station until the interference of the control signals from a plurality of base stations is removed.

A possibility that the control signal will be caught will be described with reference to the following equations. Assuming now that P_t is a probability with which the control signal is transmitted at the timing T_2 , then a probability P_1 at which control signals interfere with each other at the timing T_2 presented when the control signal

transmission timings of the two base stations overlap with each other is expressed by the following equation (1)):

$$P_1 = (1 - P_t)^2 + P_t^2 \quad \dots (1)$$

A probability P_3 at which the control signals
5 interfere with each other three times successively is expressed by the following equation (2):

$$P_3 = [(1 - P_t)^2 + P_t^2]^3 \quad \dots (2)$$

Since the processing proceeds to the out-of-service-area processing when the control signals interfere
10 with each other three times successively, P_3 represents the probability at which the processing proceeds to the out-of-service-area processing. For example, when $P_t = 1/2$, $P_3 = 1/8$. Therefore, the probability P_3 at which the processing proceeds to the out-of-service-area processing can be
15 decreased sufficiently.

In accordance with this embodiment, since a transmission of the control signal at one timing T_1 is constantly carried out at every period, if the control signals from a plurality of base stations do not interfere at
20 all, then each terminal station can reliably receive and catch the control signal by catching the control signal based on the timing T_1 . Therefore, even when the transmission of the control signal is extinguished, it is avoided that the control signal cannot be caught. Thus, the terminal station
25 can receive the control signal stably.

While the control signals are periodically transmitted twice at the close timings T_1 , T_2 as described above, the present invention is not limited thereto and a control signal transmitted in other state may be extinguished
30 randomly. As shown in FIG. 10A, for example, the control signal may be transmitted at a constant period (at the interval of 125 milliseconds) and a transmission of the control signal may be stopped at an arbitrary timing and then the control signal may be extinguished. With this
35 arrangement, even when the transmission periods of the control signals from the two base stations 1 and 2 shown in FIGS. 10A and 10B are agreed with each other, the control

signal transmitted from another base station 2 can be caught at the timing where a transmission of the control signal from one base station 1 is extinguished.

While the transmission of the control signal at the succeeding timing T_2 is extinguished randomly when the control signals are periodically transmitted twice at the close timings T_1 and T_2 , a principle of the present invention can be applied to the case that a transmission of the control signal at the preceding timing T_1 is extinguished randomly.

Further, the control signal may be transmitted three times or more during one period.

Furthermore, it is possible to randomly combine the case that the transmission of the control signal at the preceding timing T_1 is extinguished and the case that the transmission of the control signal at the succeeding timing T_2 . By way of example, the transmission of the control signal from one base station 1 shown in FIG. 11A is extinguished at a timing T_1 randomly set and the transmission of the control signal from another base station 2 shown in FIG. 11B is extinguished at a timing T_2 randomly set. At that time, even when the extinguished timings T_1 and T_2 are located within the same period, the control signals transmitted from the two base stations 1 and 2 during one period can be prevented from interfering with each other. Therefore, the control signals can be received satisfactorily by the terminal stations of the respective system.

While the present invention is applied to the case wherein the control signal is transmitted from the base station paired with the terminal stations as the digital cordless telephone system as described above, a principle of the present invention can also be applied to the case wherein a control signal is transmitted from a public base station located outdoors to communicate with a large number of terminal stations.

Furthermore, while numerical values such as the period are presented by way of example, the present invention

is not limited thereto and other time or the like can be set freely.

According to the present invention, even when the control signals from a plurality of base stations are
5 transmitted at the same timing, only the control signal from one base station can be received at the timing wherein the transmission of the control signal is extinguished. There is then the large possibility that the control signals
10 transmitted from a plurality of base stations can be received without interference. Therefore, when a plurality of base stations are located close to each other, there is then the small possibility that control signals from the respective base stations will interfere with each other. Thus, it is possible to reliably avoid the digital cordless telephone
15 system from becoming useless as a cordless telephone.

In this case, of the control signals successively transmitted a plurality of times, the control signal of any one of slots is not extinguished but constantly transmitted at a predetermined time interval, whereby the reference
20 timing at which the control signal is received at the terminal station can be determined based on the timing at which the control signal is transmitted at the predetermined interval. Therefore, even when the transmission of the control signal is extinguished randomly, the terminal station
25 can intermittently receive the control signal satisfactorily.

Having described preferred embodiments of the invention with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments and that various changes and
30 modifications could be effected therein by one skilled in the art without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. A base station of a digital communication system comprising:
 - 5 radio frequency processing means for processing an RF signal for transmitting and/or receiving digital data; and communication control means for controlling a communication to one or more terminal stations using a control channel, wherein said communication control means
 - 10 makes a control signal which has periodic pulses and some of said periodic pulses are randomly or pseudo-randomly extinguished.
2. A base station of a digital communication system as
15 claimed in claim 1, wherein said communication control means makes a first control signal having periodic pulses which are not randomly extinguished and a second control signal having periodic pulses which are randomly or pseudo-randomly extinguished.
- 20 3. A base station of a digital communication system as claimed in claim 2, wherein said first and second control signals have the same period of the pulses.
- 25 4. A base station of a digital communication system as claimed in claim 1, 2 or 3, wherein said communication control means makes a first control signal having periodic pulses which are randomly extinguished in the form of a first random or psuedo-random sequence and a second control signal
30 having periodic pulses which are extinguished in the form of a second random or pseudo-random sequence.
5. A base station of a digital communication system as claimed in claim 4, wherein said first and second control
35 signals have the same period of the pulses.

6. A base station of a digital communication system as claimed in any one of the preceding claims, wherein said digital communication system uses a signal format of TDMA.

5 7. A base station of a digital communication system as claimed in any one of claims 1 to 5, wherein said digital communication system uses a signal format of TDD.

8. A terminal station of a digital communication
10 system comprising:

radio frequency means for receiving an RF signal;

and

synchronizing means for synchronizing a signal in a received RF signal from a base station, wherein said
15 synchronizing means synchronizes a signal supplied thereto from said base station if said synchronizing means catches a synchronizing signal from said base station and executes another process if said synchronizing means does not catch said synchronizing signal from said base station.

20

9. A terminal station of a digital communication system as claimed in claim 8, wherein said signal from said base station has a first control signal which has periodic pulses and some of said pulses are randomly or pseudo-
25 randomly extinguished.

10. A terminal station of a digital communication system as claimed in claim 9, wherein said signal from said base station has a first control signal having periodic
30 pulses which are not randomly extinguished and a second control signal having periodic pulses which are randomly or pseudo-randomly extinguished.

11. A terminal station of a digital communication
35 system as claimed in claim 9, wherein said signal from said base station has a first control signal having periodic pulses which are randomly extinguished in the form of a first

random or pseudo-random sequence and a second control signal having periodic pulses which are randomly extinguished in the form of a second random or pseudo-random sequence.

5 12. A terminal station of a digital communication system as claimed in claim 10, wherein said synchronizing means catches said second control signal if said synchronizing means cannot catch said first control signal and said synchronizing means executes another processing if
10 said synchronizing means cannot catch said second control signal.

13. A terminal station of a digital communication system as claimed in claim 11, wherein said synchronizing
15 means catches said second control signal if said synchronizing means cannot catch said first control signal and said synchronizing means executes other processing if said synchronizing means cannot catch said second control signal.

20

14. A communication system comprising:
a base station; and
one or more terminal stations of a digital signal,
wherein said communication system uses a control signal which
25 has periodic pulses and some of said pulses are randomly or pseudo-randomly extinguished.

15. A communication system as claimed in claim 14,
wherein said communication system uses a first control signal
30 having periodic pulses which are not randomly extinguished and a second control signal having periodic pulses which are randomly or pseudo-randomly extinguished.

16. A communication system as claimed in claim 14,
35 wherein said communication system uses a first control signal having periodic pulses which are randomly extinguished in the form of a first random or pseudo-random sequence and a second

control signal having periodic pulses which are randomly extinguished in the form of a second random or pseudo-random sequence.

5 17. A communication system as claimed in any one of claims 14 to 16, wherein said communication system uses a signal of TDMA and/or TDD.

18. A method of receiving a control signal comprising
10 the steps of:
receiving a first control signal in a first manner;
receiving a second control signal if said first control signal has not yet been received; and
receiving said first or second control signal in a
15 second manner if said second control signal has not yet been received.

19. A method of receiving a control signal as claimed in claim 18, wherein said first manner is an interval
20 reception and said second manner is a continuous reception.

20. A method of sending a control signal in a base station of a digital communication system comprising the steps of:
25 making a control signal having periodic pulses, some of which are randomly or pseudo-randomly extinguished; and
transmitting an RF signal modulated by at least said control signal made from said control signal making
30 step.

21. A base station of a digital communication system constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated
35 in figures 4 to 11B of the accompanying drawings.

22. A terminal station of a digital communication system constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in figures 4 to 11B of the accompanying drawings.

5

23. A communication system constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in figures 4 to 11B of the accompanying drawings.

10

24. A method of receiving a control signal substantially as hereinbefore described with reference to and as illustrated in figures 4 to 11B of the accompanying drawings.

15

25. A method of sending a control signal substantially as hereinbefore described with reference to and as illustrated in figures 4 to 11B of the accompanying drawings.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17
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 MR N HALL

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 14 FEBRUARY 1996

Databases (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-

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(ii) ONLINE: WPI

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